and covered it with a dye, that in the spectrum, where the dye absorbed, there a photographic action, although beyond the usual boundary of photographic action, would be seen. We followed up this very carefully, hoping to find some dye by which we might be able to photograph the ultra-red rays of the spectrum. Had I known as much then as I do now I should not have followed any such chimerical idea. But what Vogel stated was perfectly correct, viz. that in that regions of the spectrum which certain dyes absorbed, a photographic action would take place. Suppose I take a plate prepared with some silver salt, and flow over it a dye, and then expose it to the spectrum; I find where the dye absorbed there a photographic image was formed. What was the meaning of this? This required investigation as well. The first dye that was taken up was that of cyanin blue. I have here a plate covered with cyanin blue, and when this plate was placed in the spectrum it was found that it bleached in the yellow, No. II. Fig. 5. Now what was the meaning of that bleaching in the yellow? Let us consult the absorption spectrum of cyanin blue, to see whether it absorbs in that particular part of the spectrum; for if it absorbs in that particular part there work must be done as I have already shown you. I will throw the spectrum on the screen, and then introduce a solution of cyanin blue in front of the slit of the lantern, No. I. Fig. 5. We do this, and it will be seen that there is great absorption in the yellow, so that that particular portion of spectrum bleached the cyanin blue which the cyanin blue cut off. So that work and absorption went hand in hand: when the action was investigated more closely, it was found

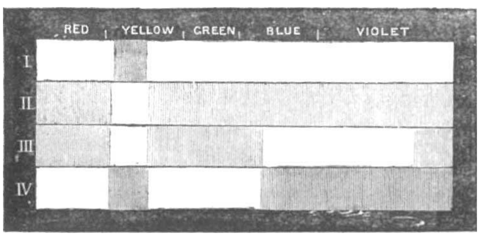

FIG. 5.—I., absorption spectrum of cyanin blue; II., bleaching effect of spectrum on paper stained with cyanin blue; III., bleaching effect of spectrum on a silver bromide film stained with cyanin blue; IV., photographic impression of spectrum prepared as in III. The shaded parts show metallic silver on development.

that the work performed was an oxidation; in other words, that bleaching took place through the effect of oxidation. So much for cyanin blue, *per se;* when, however, we took a plate covered with bromo-iodide of silver in collodion, and dyed with cyanin blue, exposing it for some time to the spectrum, it was found not only that the cyanin was bleached in the yellow, but it was also bleached in the blue, No. III. Fig. 5. It should be remembered that the only factor of difference was in the first case we had cyanin blue, in the collodion by itself, and in this last the dye and iodide and bromide of silver. What then was the explanation of this? That required a further investigation, and I think, perhaps, I shall be able to show you what really did happen. I will take that same cell of cyanin blue used before, and place it in front of the slit of the lantern, and we have the cyanin absorption spectrum on the screen. Now I have told you that when bromide of silver or iodide of silver is exposed to light, one atom of iodine or bromine is given off, and if the exposure be prolonged the amount is measurable, therefore it is possible that the bleaching action in the blue might be due to the action of bromine, and if so, bromine ought to be able to bleach cyanin blue. If we take bromine water and drop it into the cell, I think you will find that the whole spectrum will appear again in its usual brilliancy; we drop the bromine water in, and the whole spectrum does appear on the screen. Our question then is answered. The bromine liberated from the bromide of silver by the action of light when the dyed film was placed in the spectrum, was able to bleach it in the blue part of the spectrum in the same way that the oxygen in the air was able to bleach it under the influence of the yellow rays.

Now I will show you what the action of oxidised matter on silver is. Here we have a glass plate on which was written "May 25th" with an oxidised solution of albumen. This was coated with a collodion film containing bromide and iodide of silver, and developed in the usual way. You will see that where the oxidisable matter is placed, there we have a deposition of silver upon those particular portions. Apply this to the spectrum developed on a plate stained with cyanin blue; where it is bleached in the yellow, the oxidised dye will cause a deposit of silver to be formed,[1] whilst where the blue rays have acted we shall have a deposition of silver due to ordinary development, as already explained. I throw upon the screen a spectrum showing this. The film of collodion containing the silver salts was dyed, and then the bromide of silver dissolved away. You see we have a bleaching in the yellow and also a bleaching in the blue, one being due to the oxidising action of the yellow rays on the plate, the other due to the action of the bromine upon the dye itself. Next I will show you a photograph (No. IV. Fig. 5) of the spectrum taken on such a dyed plate. We have the part impressed by the blue rays, and a deposition of silver as before, and also we have the yellow where there is another strong deposition of silver. For convenience' sake I have photographed the absorption spectrum of cyanine and placed it below the spectrum photographed on the silver stained with cyanin. You will thus see that the band in the yellow impressed on the latter plate corresponds exactly with the absorption of the cyanin blue itself.

Carrying the investigation a little further, it was found that the same took place with eosin. I have an eosin solution here, and here is an absorption-spectrum of eosin which cuts off a great deal of the green—we have the yellow, but the green is cut out and the blue is damped. The green is the principal portion which is absorbed; in other words, the work which has to be done on the dye will be done in that part of the spectrum. In the photograph of the spectrum of eosin taken with bromide of silver dyed with eosin, you see as a result that we have the plate impressed by the blue rays, and also the plate impressed by the green. The deposition of silver on the two parts is due to different causes: that in the green is due to the work done on the dye; the work was not done on the silver directly, but on the dye first. That on the blue was due to the work done on the silver bromide itself. I may say that all dyes which I have found useful in the photographic sense are what we call fugitive dyes; in other words, dyes which fade in the light. Ladies are perfectly well acquainted with the fact that some dyes will not stand well; those which fade most rapidly give the best results in spectrum photography.

(*To be continued.*)

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—The Clothworkers' Exhibition for proficiency in Physical Science, tenable for three years by an unattached student at Oxford or Cambridge, has been awarded to J. Davies. The next Clothworkers' Exhibition will be awarded for Physical Science by means of the examination for certificates to be held next July by the Oxford and Cambridge Schools Examination Board. Candidates must be non-collegiate students of one term's standing at Oxford or Cambridge, or non-residents who are prepared to enter as such.

The oral and practical examinations in the second part of the Natural Sciences Tripos concluded on Monday last (12th).

Prof. Stuart has now thirty-eight pupils in mechanism and engineering, and more space and new machinery are needed to meet their growing requirements. A new room measuring thirty-six by twenty-five feet is asked for, with motive power, a heavy lathe, a slotting machine and larger forge. Messrs. Greenwood and Batley will present a slotting machine when there is a place to put it in. The building will cost 225*l*.

Mr. D. MacAlister, Fellow and Medical Lecturer of St. John's College, will lecture on Methods of Physical Diagnosis three times a week next term, beginning February 2.

SOCIETIES AND ACADEMIES

LONDON

Linnean Society, December 3.—Sir John Lubbock, Bart., president, in the chair.—Mr. J. Harris Stone exhibited specimens of the dried plant and made remarks on *Lychnis viscaria* as a

[1] It has been objected by Dr. Vogel that the bleaching action requires time to effect it, and that the phenomenon is visible after a short exposure. The simple answer to the question is, When does the bleaching commence? The merest trace of reduced dye would act as a nucleus for development, as does the merest immeasurable trace of subiodide or bromide.

trap for ants. He pointed out that three or four glutinous or sticky rings are situate immediately underneath the nodes in the flowering stalks. Ants climbing the stems are arrested and die in numbers at the sticky zones, and few reach the flower. In Norway last summer he had observed as many as 95 per cent. of the plants with dead and dying ants thereon; and he therefore submits whether the zones are a protection to the flowers? the ants noxious? or that their dead bodies ultimately serve as pabulum for the plant? Dr. T. S. Cobbold exhibited diseased roots of *Stephanotus* which he had received from Dr. Masters. They swarmed with myriads of nematode worms and were also covered with minute Acari. He referred the worms to the genus *Leptodera*, and stated that thirty-three years back he discovered similar parasites in the shrivelled leaves of Gloxinias.—Dr. Maxwell Masters read a note on the foliation and ramification of *Buddleia auriculata*. He shows from a study of the mode of development and other considerations that the leafy auricles between the petioles represent leaves of a whorl, so that the verticil consists of two perfect and two imperfect leaves. An additional link between Loganiaceæ and Rubiaceæ is thus afforded. Further details were given concerning the multiple axillary buds in this plant and the supra-axillary shoots. Some of the peculiarities alluded to are usually explained on the hypothesis of fusion, but the author shows that in this, as in many similar cases, the appearances are due to an arrest of development, in consequence of which parts that should become free in course of growth remain inseparate, and in some cases are "uplifted" with the axis as it lengthens, and are thus removed from their normal position.—Prof. Owen read a paper on the homology of the conario-hypophysial tract, or the so-called pineal and pituitary glands. He propounds the view that it is the modified homologue of the mouth and gullet of Invertebrates; that the sub-œsophageal ganglia or ganglionic masses or neural cords constitute the centres whence are derived and caudally continued the homologues of the Vertebrate myelon.—Mr. McLachlan communicated a paper on the Neuroptera of Madeira and the Canary Islands. Prompted by the researches of the Rev. A. E. Eaton in November and December, 1880. The author gives a *résumé* of all that had been published on the subject, and a tabular statement of the species found in the islands, indicating those known also to exist in Europe. In all about 53 species had been noticed from the islands, of which 19 are known inhabitants of the European continent, and 4 African; 37 species had been found in Madeira, 31 in the Canaries, 16 being common to both. The paper concluded with a detailed account of the species, including descriptions of several new ones.—The following gentlemen were balloted for, and elected Fellows of the Society:—Capt. P. Greene, G. S. Jenman, W. Landau, E. G. Warnford Lock, Rev. T. P. H. Sturges, Lieut.-Col. C. Swinhoe, G. C. Walton, C. S. Wilkinson, G. S. V. Wills, and Rev. Geo. Wilson.

Mathematical Society, December 8.—Mr. S. Roberts, F.R.S., president, in the chair.—Mr. G. H. Stuart, M.A., late Fellow of Emmanuel College, Cambridge, was elected a Member, and Miss C. A. Scott was admitted into the Society.—The following papers were read:—On the polar planes of four quadrics, Mr. W. Spottiswoode, Pres. R.S.—On some forms of cubic determinants, Mr. R. F. Scott.—On the flow of a viscous fluid through a pipe or channel, Prof. Greenhill.—The covariant which is the complete locus of the vertex of the involution pencil of tangents to a cubic, Mr. J. J. Walker.

Chemical Society, December 1.—Prof. Roscoe, president, in the chair.—The following papers were read:—Researches on the laws of substitution in the naphthalene series, Part ii., by Dr. Armstrong and Mr. Graham. The product of the action of cold sulphuric acid on β naphthol proves not to be identical with the isomeric sulphonic acid of Rumpf, but to be β naphthylsulphonate. The same substance may be obtained pure by the action of sulphochloride on β naphthol. By studying the reactions of this body the authors prove that bromine and the sulpho group do not assume the same position in the body when the sulphate is treated with bromine and sulphochloride respectively, and express the opinion that modifications of the OH group appear to lead to important modifications of the laws of substitution. A third and a fourth isomeric naphthalene-disulphonic acid have been obtained.—On benzylphenol and its derivatives, by E. H. Rennie. The author has obtained a monosulphonic acid and its salts in a crystalline condition. He has investigated the action of nitric acid and of bromine on the salts. He believes benzolphenol to be a para derivative.—Note on the action of ethyli chlorocarbonate on benzene in the presence of aluminic chloride, by E. H. Rennie.—On peppermint camphor and some of its derivatives, by R. W. Atkinson and H. Yoshida. The authors have studied the action of bichromate on this camphor. Menthone is produced; from its reactions the authors conclude that the relation between menthol and menthone is similar to that between borneol and camphor. They have examined the physical properties of these derivatives, and give the probable constitution of these bodies.—On the production of oxalic acid from paraffin oil, by J. Galletly and J. S. Thomson. The authors have acted on paraffin oil from shale, with nitric acid, and find that oxalic acid is produced.

Physical Society, November 26.—Prof. W. G. Adams in the chair.—Mr. C. Vernon Boys read a paper on integrating apparatus. After referring to his original "cart" machine for integrating, described at a former meeting of the Society, he showed how he had been led to construct the new machine exhibited, in which a cylinder is caused to reciprocate longitudinally in contact with a disk, and give the integral by its rotation. Integrators were of three kinds: (1) radius machines, (2) cosine machines, (3) tangent machines. Sliding friction and inertia render the first two kinds unsuitable where there are delicate forces or rapid variations in the function to be integrated. Tangent machines depend on pure rolling, and the inertia and friction are inappreciable. They are therefore more practical than the other sort. It is to this class that Mr. Boys' machines belong. The author then described a theoretical tangent integrator depending on the mutual rolling of two smoke rings, and showed how the steering of a bicycle or wheelbarrow could be applied to integrate directly with a cylinder either the quotient or product of two functions. If the tangent wheel is turned through a right angle at starting, the machine will integrate a reciprocal, or it can be made to integrate functions by an inverse process. If instead of a cylinder some other surface of revolution is employed as an integrating surface, then special integrations can be effected. He showed a polar planimeter, in which the integrating surface is a sphere. A special use of these integrators is for finding the total work done by a fluid pressure-reciprocating engine. The difference of pressure on the two sides of the piston determines the tangent of the inclination of the tangent wheel which runs on the integrating cylinder, while the motion of the latter is made to keep time with that of the piston. In this case the number of revolutions of the cylinder measures the total amount of work done by the engine. The disk cylinder integrator may also be applied to find the total amount of work transmitted by shafting or belting from one part of a factory to another. An electric current meter may be made by giving inclination to the disk, which is for this purpose made exceedingly small and delicate, by means of a heavy magnetic needle deflected by the current. This, like Edison's, is a direction meter, but a meter in which no regard is paid to the direction of the current can be made by help of an iron armature of such a shape that the force with which it is attracted to fill the space between the poles of an electromagnet is inversely as its displacement, and then, by resisting this motion by a spring or a pendulum, the movement is proportional to the current, and a tangent wheel actuated by this movement causes the reciprocating cylinder on which it runs to integrate the current strength. Mr. Boys exhibited two such electric-energy meters, that is, machines which integrate the product of the current strength by the difference of potential between two points with respect to time. In these the main current is made to pass through a pair of concentric solenoids, and in the annular space between these is hung a solenoid, the upper half of which is wound in the opposite direction to the lower half. By the use of what Mr. Boys calls "induction traps" of iron, the magnetic force is confined to a small portion of the suspended solenoid, and by this means the force is independent of the position. The solenoid is hung to one end of a beam, and its motion is resisted by a pendulum weight, by which the energy meters may be regulated like clocks to give standard measure. The beam carries the tangent wheels, and the rotation of the cylinder gives the energy expended in foot pounds or other measure. The use of an equal number of turns in opposite directions on the movable solenoid causes the instrument to be uninfluenced by external magnetic forces. Mr. Boys showed on the screen an image of an electric arc, and by its side was a spot of light whose position indicated the energy and showed every flicker of the light and fluctuation of current in the arc. He showed on the screen that if the poles are brought too near the energy expended is less, though the current is stronger, and that if the poles are too far apart, though

the electromotive force is greater, the energy is less; so that the apparatus may be made to find the distance at which the greatest energy, and so the greatest heat and light, may be produced.—At the conclusion of the paper Prof. W. G. Adams and Prof. G. C. Foster could not refrain from expressing their high admiration of the ingenious and able manner in which Mr. Boys had developed the subject.

December 10.—Prof. W. G. Adams in the chair.—New members: Lieut. C. E. Gladstone, R.N., Lieut. C. Gauntlett Dicken, R.N., Mr. Walter George Woolcombe, B.A., F.L.S., Rev. Prof. Sircomb, Mr. Arthur Clayden, M.A.—Prof. Adams said that it had been thought advisable to invite the members to view the Smoke Abatement Exhibition now opened, and the meeting was adjourned for that purpose; Prof. Chandler Roberts acting as guide.—The next meeting of the Society will be held on January 28.

PARIS

Academy of Sciences, December 5.—M. Wurtz in the chair.—The first volume of the works of Cauchy, the first of a new edition of the works of Niels-Henrik Abel, and the scientific MSS. of Chasles, were presented and commented upon.—General survey map of France, by M. Perrier. This is a work of the geographical service of the War Department, and indicates, by curves, the orography of the country.—Meridian observations of small planets and of comet *b* of 1881 at Paris Observatory, during the third quarter of 1881, by M. Mouchez.—On the theory of chain-shot, by M. Resal.—On some applications of the theory of elliptic functions, by M. Hermite.—Chemical studies on the skeleton of plants, by MM. Fremy and Urbain. The substances forming the skeleton are chiefly pectose and its derivatives, cellulosic substances in their different isomeric states, cutose, and vasculose. The results of analyses of stems, roots, leaves, petals, fruits, and seeds, also of the tissues of champignons, are given. It is thought they may be useful to botanists for classification, for physiological studies, for study of manures, and fossil fuel, &c., and that they have also indnstrial uses.—Summary account of a zoological exploration in the Atlantic, in the *Travailleur*, by M. Alph. Milne-Edwards. This exploration was chiefly off the coasts of Spain and Portugal, in August. In one case dredging was done at the great depth of 5100 m., where numerous animals were met with, small indeed, but of high groups (annelids, crustaceans, &c.); the temperature was $+3^{\circ}\cdot5$. Near the Spanish coast, and beyond 1000 m. depth, numerous polypiers, mostly unknown, showed marvellous development at some points. Among other "finds" were three very rare sharks (at 1200m.), which seem never to leave the depths, a Norwegian Pontophile, which had been thought peculiar to northern seas, a new Pontophile, a gigantic Pycnogonidian, ten new genera of Bryozoa, magnificent corals of the genera *Lophohelia* and *Amphihelia*, a remarkable *Asteria* representing a new genus, an organism got at 1145m., which may belong to the group of Infusoria, and (there also) a fine *Eugliphus* like *Difflugies* of fresh water.—On certain meteorological stations it is proposed to establish in the neighbourhood of the North Pole, by M. Faye. He thinks little of the project. Its authors consider that the ice of polar regions is *perhaps* the regulator of our climates; but modern science shows the regulator to be rather in the vast equatorial zone, whence storms travel over the two hemispheres. After expounding his conception of these phenomena, Mr. Faye points out that France would do better to organise a meteorological station in the Azores rather than at Cape Horn.—On the theory of linear differential equations of the second order, by M. Brioschi.—Deposit of metallic layers of different colours by electricity, by M. Weil. Using a single copper bath, he can cover steel or brass *e.g.* with bright layers of such and such a colour at will, by means of different suboxides of copper, whose chemical nature is not yet determined. The same bath will produce the whole series of colours according to the manner of exposing the pieces. The effect is not one of thin plates.—Observations in 1881 on phylloxera and on the means of defence adopted, by M. Boiteau.—Observations of solar spots and faculæ at the Observatory of the Roman College during the third quarter of 1881, by M. Tacchini. An exceptional *maximum* of spots occurred in July (as predicted). The solar activity has gone on increasing, with special periods of greater frequency of spots, nearly corresponding, as before, to a half-solar rotation. The faculæ show a marked maximum in September.—On the spectrum of Encke's comet, by M. Tacchini. This, observed on November 8, had the three carbon bands (the central brightest) shaded off on the violet side; the weak continuous spectrum of the nucleus forming a uniform straight line across the bands.—On Wendell's comet (*g* 1881), by M. Tacchini.—Rectification and addition to a previous note on the curve of the solar spots, by M. Duponchel. He predicts that the next sun-spot maximum will not be before 1890 (others say 1882), perhaps 1888, but more probably 1892.—On the curves defined by differential equations, by M. Poincaré.—Distribution of energy by electricity, by M. Deprez.—On the determination of the ohm; reply to M. Brillouin, by M. Lippmann.—Variations of the resistance of electric machines with their velocity, by M. Lacoine. He shows reason for thinking these variations are explained by those of contact between the movable commutator and the springs in friction.—Determination of the illuminating power of simple radiations, by MM. Crova and Lagarde. Sunlight and a Carcel lamp were compared. Part of the spectrum is isolated with a slit, and a Nicol turned till striæ cease to be perceptible. With the lamp the maximum corresponds to the radiation 592; with the sun, to 564.—On the velocity of cooling of gases at high temperatures, by MM. Maillard and Le Chatelier.—Combination of hydrogen with oxygen under the influence of electric *effluves*, by MM. Deherain and Maquenne. The state of humidity of the surfaces between which the *effluve* is produced affects profoundly the nature of the discharge, both as to external aspect, and to its action on the gases.—On the titrage of œnoline and œnotannin in wines, by M. Jean.—Meteorological observations during a balloon ascent on October 20, 1881, by MM. Duté, Poitevin, and Du Havel. These relate chiefly to formation of clouds.—Observation of palpebral reflex in chloroformic anæsthesia, by M. Berger.—On the convulsing action of morphine in mammalia, by MM. Grasset and Amblard. All researches on the antagonism of various medicaments to morphine should be revised, the substances opposing the soporific effects, and those opposing the excito-motor effects of the alkaloid, being studied separately.—Researches on the history of generation in insects, by M. Jobert.—On the post-embryonal development of diptera, by M. Viallanes.—Researches on the action of digestive juices of cephalopoda on amylaceous matters, by M. Bourquelot. The liver and pancreas produce or contain a ferment which has no action on raw fecula, but which changes hydrated starch into sugar.—On the diamantiferous beds of Minas Geraës, Brazil, by M. Gorecix.—M. De Lesseps gave some information with regard to the scheme for piercing the Isthmus of Corinth.

VIENNA

Imperial Academy of Sciences, December 1.—V. Burg in the chair.—The following papers were read:—R. Andreasch, on some further examples of syntheses of the sulphydantoins by means of thioglycollic acid.—Anton Tomaschek, on the power of movement of pollen-bags and pollen-tubes.—W. F. Loebisch and Dr. A. Looss, on the action of carbonic oxide gas on monopotassium glycerate.—On the preparation of dipotassium glycerate, by the same.—T. Hann, on the monthly and yearly oscillations of temperature in Austro-Hungary.

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